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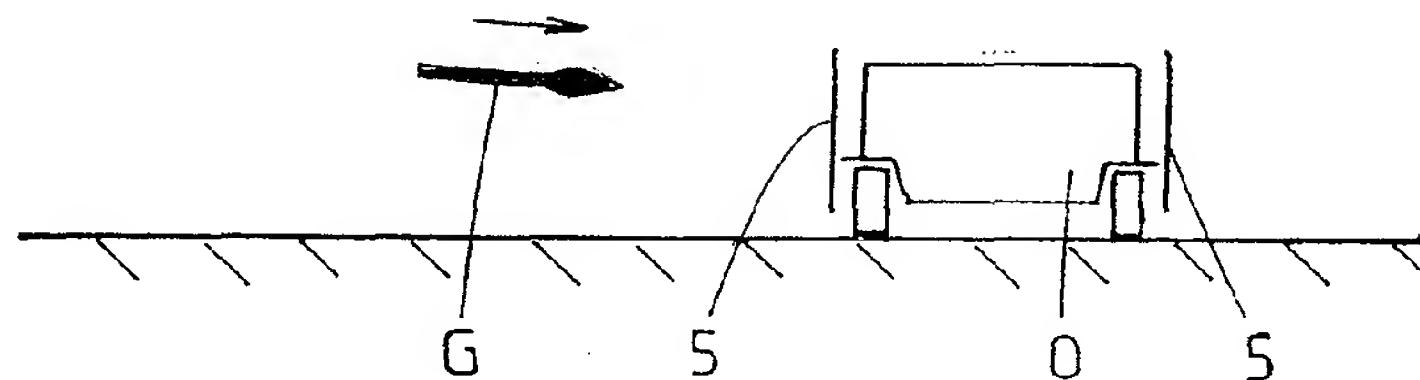
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(54) Title: METHOD AND DEVICE FOR PROTECTING OBJECTS AGAINST ROCKET PROPELLED GRENADES (RPGS)



(57) Abstract: The invention relates to a method for protecting objects (O) against rocket-propelled grenades (G) having a hollow nose cone (4). A netting (5) of knotted and coated superstrong fibres is disposed in front of the object, in such a manner that the nose cone of a rocket caught in the netting will penetrate one of the meshes of the netting and be deformed through strangulation, thereby disabling the detonator. A device to be used with said method comprises a netting of knotted superstrong fibres provided with a flexible coating, formed with a plurality of meshes having a stretched mesh length of maximally about 8 cm.

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Method and device for protecting objects against rocket-propelled grenades (RPGs).

The present invention relates to a method and device for protecting objects against rocket-propelled grenades (RPGs) having a hollow nose cone. The invention further relates to an armoured vehicle provided with armour plating and with such a device, as well as to the use of such a device for protecting a fortified military post, for example. Finally, the invention relates to a method for manufacturing such a device.

RPGs, in particular the RPG7, are rocket weapons that have been spread in very large numbers all over the world since the sixties. Such weapons are especially used in so-called asymmetric warfare, i.e. in combats between armies having armoured vehicles and/or tanks and groups mainly armed with hand-held weapons. An RPG7 rocket is a very effective weapon against armoured vehicles, its hollow charge enabling it to penetrate more than 250 mm thick armour plating. Such weapons are also used against buildings.

The RPG7 is a rocket having a hollow nose cone, whose inner side functions as part of the detonation circuit of a detonator, which must detonate the hollow charge upon impact of the rocket with an object.

In the past several attempts have been made to provide a protection device. For example, RU 2 125 224 discloses a shield for a tank or a combat vehicle, in which use is made of a single-layer or multilayer netted or grid shield made of steel wire or bars. The shields are mounted to the four sides of the tank or the combat vehicle via parallelogram mechanisms, which enable the shields to take up a combat position or a travelling position. In the combat position, the shield is spaced from the armour

plating by a distance of up to 2-3 m, whilst in a travelling position the shield is disposed quite close to the armour plating. Such a shield has proven not to be very effective in practice, whilst the shields add significantly 5 to the weight of the tank.

The object of the invention is to provide a new protection method as well as a device which combines a low weight with an effective operation.

In order to accomplish that object, the invention 10 provides a method for protecting objects against rocket-propelled grenades having a hollow nose cone, wherein a netting of preferably knotted and coated superstrong fibres is disposed in front of the object, wherein the size of the meshes of the netting has been selected so that a nose cone 15 of a rocket caught in the netting will penetrate one of the meshes of the netting and be deformed through strangulation, thereby disabling the detonator.

The invention further provides a device for 20 protecting object against rocket-propelled grenades, comprising a netting of superstrong fibres, which are preferably knotted and provided with a flexible coating, formed with a number of meshes having a stretched mesh length of maximally about 8 cm.

By using knotted netting of superstrong fibres, a 25 protection device which can have a low weight is obtained. Dyneema® may be used as the superstrong fibre, but it is also conceivable to use other known fibres, such as aramid, Spectra® or ballistic nylon. Also combinations of materials are possible. To obtain high knot strength, it is 30 advantageous to coat the fibres with a flexible material, preferably comprising moisture-resistant and elastomeric components, such as PUR (polyurethane). Such netting makes it possible to exert a so-called strangulation effect on the nose cone of the grenade, so that the grenade is caught 35 and directly disabled due to the short-circuit that is caused in the detonator circuit extending through the nose

cone, as a result of which no signal transfer can take place from the piezo-electric sensor in the nose to the detonator. The grenade can thus be deactivated in the course of a very short distance, making it possible to dispose the netting quite close to the object.

Such a strangulation effect can be achieved in an effective manner by using a stretched mesh length of preferably maximally 8 cm and preferably minimally 7 cm.

It is advantageous if the netting is pre-stretched after being knotted, preferably after being coated, preferably with a force such that the fibres are loaded to a tension of about 0.2 to 0.5 times the breaking stress of the knots. In this way the amount of slip that occurs at the knots during said strangulation can be minimised.

It is advantageous in that case if the netting is so configured that the meshes are capable of withstanding a circumferential load of minimally about 3 kN, whilst the mesh legs preferably have a diameter of maximally about 4 mm.

With the aforesaid minimum circumferential load, those forces that occur upon strangulation of a grenade penetrating the meshes can be sufficiently withstood to enable strangulation of the nose cone. Preferably, the smallest possible mesh leg diameter is used, because this minimises the chance that the hollow charge of the grenade is still detonated by the impact of the grenade with a mesh leg or a knot of the netting. Equilibrium needs to be found between the strength of the netting and the thickness of the fibres used therein.

In a special embodiment, in which the meshes are formed by at least three mesh sides, each mesh side is made up of at least two separate fibres, which preferably extend at least substantially parallel to each other. In this embodiment only one of the two fibres of each mesh side functions as a spare fibre in case the other fibre should break upon impact or during strangulation of the grenade.

In this way an even more reliable operation can be realised. The fibres preferably extend parallel to each other, because this reduces the risk of the grenade detonating on the mesh legs of the net or of the two fibres breaking simultaneously.

In order to further enhance the deformation of the nose cone for the purpose of disabling the detonator of the grenade, the meshes may be provided with projections, such as beads, between the knots thereof. Such projections cause a local deformation of the nose cone, so that a short-circuit will occur even sooner. Such projections make it possible to use comparatively larger meshes and thus reduce the risk of the detonator detonating on the netting, or on the other hand to cause a short-circuit sooner, making it possible to dispose the netting closer to the object to be protected.

In another special embodiment the device is provided with two nettings disposed one behind the other, perpendicular to the plane thereof. In this case the second netting, seen in the direction of movement of the grenade, functions as spare netting in case the first netting should fail. Depending on the application, the nettings can be so disposed that the meshes of the two nettings are aligned, but in other cases it may be advantageous for the nettings to be staggered relative to each other.

To increase the knot strength and prevent slip in the knots of the netting it may be advantageous if each knot is a double knot. Also in this case equilibrium will have to be found between increasing the risk of the hollow charge detonating on the knot and realising less slip in the knots and thus increasing the chance of a successful strangulation of the nose cone of a grenade.

A special application of the device according to the invention is on an armoured vehicle, in which case the device comprises means of attachment for disposing the netting at the distance of about 15-50 cm from the armour

plating. Such a small spacing can be achieved as a result of the good strangulation effect provided by the device, and such a small spacing has a positive effect on the vehicle characteristics, of course. Such a small spacing 5 will hardly affect the appearance of the vehicle, whilst in addition the serviceability of the vehicle will not be adversely affected to any significant extent.

Consequently the invention also relates to an armoured vehicle provided with armour plating and with a 10 device as described in the foregoing, comprising means of attachment for disposing the netting of the device at a distance of about 15-50 cm from the armour plating.

The aforesaid spacing between the netting and the armour plating can be maintained in a simple manner if a 15 foam material or an air cushion is placed between the vehicle and the netting, and the netting is preferably stretched against the foam material or the air cushion. In this way the netting can be attached to the vehicle in a simple manner without adding to the weight of the vehicle 20 to any significant extent. In practice it has become apparent that the inertia forces of the netting itself are so large that means of attachment are hardly needed, if at all, for keeping the netting in place upon impact of a grenade.

25 Although the device according to the invention can function in a fully passive manner, at least part of the device may also play an active part, for example if the air cushion is inflatable and comprises one or more sensors for detecting an acute threat and causing the air cushion to inflate prior to the impact of a grenade. In that case the netting is not positioned at the desired distance from the armour plating until just before the grenade impacts, so 30 that the netting can be disposed even closer to the armour plating in an inactive position.

35 Another application of the device according to the invention is to protect a fortified military post, such as

an observation tower or observation post, an ammunition depot or the like, wherein the netting is suspended from a frame at its circumference, or at least at the upper side and possibly at the bottom side, at a distance of at least 5 50 cm, and preferably about 1-2 m, from the object to be protected, for example a fortification thereof or therefor. With such an application, the spacing between the netting and the object to be protected is less critical, so that the need to deactivate the grenade within a very short 10 distance is less urgent in this embodiment.

The invention further relates to a method for manufacturing netting for use as a protection against RGPs, comprising the steps of forming the knotted netting from superstrong fibres, impregnating the obtained netting with 15 a flexible coating, allowing the coating to dry and pre-stretching the knotted netting.

In practice it has become apparent that a very great knot strength exhibiting very little slip can be obtained if the netting is pre-stretched, and the knots are therefore tightened after the coating has dried rather than before said drying, as is usual. It is preferable to tension and pre-stretch the netting a number of times, for example three times, since the extent of slip can be reduced even further in this manner.

25 The invention will be explained in more detail hereinafter with reference to the drawings, which very schematically show embodiments of the invention,

30 Fig. 1 is a longitudinal sectional view of an RPG7 rocket, in which the upper half shows the nose cone in undamaged condition and the lower half shows the nose cone in strangulated condition.

Fig. 2 is a sectional view along the line II-II in Fig. 1, in which the nose cone is shown in the completely strangulated condition.

35 Figs. 3 and 4 are front views of two possible embodiments of the netting of the device according to the

invention.

Fig. 5 is a larger-scale front view of an embodiment of the netting with possible hit locations of the nose of a grenade on the netting.

5 Figs. 6, 7, 8 are very schematic views of three possible applications of the netting according to the invention, viz. for protecting a building, for protecting an additionally fortified stationary object and for use on a mobile object, such as a vehicle or a vessel.

10 Figs. 9 and 10 are very schematic views of two possible manners of attaching netting to a mobile object.

As already said before, Figs. 1 and 2 very schematically show the construction principle of the detonation system of an RPG7. The figures show the piezo-electric impact sensor 1 in the nose of the grenade G, a detonator 2 of the hollow charge with a circuit path connected to the minus side of the detonator 2, such as a wire 3, and a nose cone 4 connected to the plus side of the detonator 2. Fig. 1 shows that it is possible to cause a short-circuit in the detonation circuit, thereby preventing detonation, by deforming the nose cone 4 of the grenade in such a manner that the coating applied to the inner side of the nose cone is broken, thereby exposing the metal of the nose cone, and subsequently making a short-circuit with the other pole in the detonation circuit. To that end it is necessary for the nose cone 4 to undergo a comparatively large local deformation, in which the cone is on the one hand deformed sufficiently far towards the inside to make contact with the circuit wire 3, whilst on the other hand the coating on the inner side of a nose cone is deformed sufficiently strongly to cause it to break.

Such a deformation of the nose cone 4 is shown in Fig. 2, in which a local deformation has been effected at three locations (indicated by arrows), which local deformation is large enough to break the coating at said locations and expose the metal of the cone. A short-circuit

may subsequently be triggered at the aforesaid three locations.

Such a deformation can be effected by catching the nose cone 4 of an RPG in a mesh of netting, with the mesh sides or legs of the netting tightening round the nose cone 4 like a noose as the nose cone penetrates further into the mesh, thereby strangulating the nose cone, as it were, and causing it to deform. Such a strangulation effect can occur when a number of conditions are met. In the first place, 10 the netting must offer sufficient resistance to the penetration of the grenade, but in most cases the mass inertia forces of the netting are sufficiently large to effect this. In the second place, a mesh cell must be sufficiently strong to withstand the forces being exerted 15 thereon, i.e. both the mesh sides or legs and the knots. The strength of the mesh sides depends on the strength of the fibres used therefor, whilst the strength of the knots is mainly determined by the slip resistance thereof. The size of the meshes is preferably large enough that the nose 20 cone can easily penetrate the mesh and small enough that the largest diameter of the cone of the rocket is larger than the diameter of the mesh.

According to the invention, netting is provided having properties such that there is a relatively great 25 chance that a grenade will be deactivated upon being caught. The netting is to that end made of a superstrong fibre, with Dyneema® being preferred, but also aramid, HDPE, Spectra® or ballistic nylon-12 or PBO may be considered, for example. The fibres may be braided or laid 30 up. In the case of braided fibres or rope, an aramid core may be provided, for example, which aramid core forms an anti-cut-through element, for example in case the nose cone of the grenade is externally provided with cutting blades. It would also be possible to braid metal into the sheath of 35 the braided rope. Preferably, the smallest possible diameter of the rope formed by the fibres is used so as to

5 prevent detonation on the netting. In the case of a Dyneema® fibre a diameter of about 4 mm will suffice, for example, for withstanding a sufficiently large circumferential load on a mesh cell of minimally about 3 kN.

10 The circumferential load to be withstood is also determined by the knots of the netting. Said knots must have a high slip resistance, and this can be realised in particular by using a double knot. Such a double knot can be used successfully when the fibre diameter is relatively 15 small, since the risk of detonation on a knot will be comparatively small in that case.

20 The amount of slip in a knot can be minimised by impregnating the netting with a coating comprising moisture-resistant and elastomeric components, such as PUR, Latex or a bitumen coating. Such a coating is multifunctional. It stabilises the knot, it increases the strength of the knots and the fibres, it reduces wear and enhances the weather resistance. It can also camouflage the 25 netting if a colorant is incorporated in the coating. The amount of slip is minimised by tightening the knot with a force of about 0.2-0.5 times the breaking stress of the knot.

30 As Figs. 3 and 4 show, the netting 5 may be of a diagonal type (Fig. 3) or of an orthogonal type (Fig. 4). The meshes may be square, but this is not necessary. The ratio of the number of meshes per unit length in two directions may range between 3:4 and 4:5, for example, resulting in a diamond shape to a greater or smaller extent.

35 Fig. 5 shows the possible hit locations on netting 5. In the illustrated embodiment, so-called duplex netting is used, in which each leg 6 of a mesh between two knots 7 consists of two fibres or ropes, which are preferably untwisted and extend parallel to each other, therefore. Such duplex netting is especially advantageous in case of a

subcritical hit on a leg of the mesh, when one of the two fibres is damaged and the other fibre can subsequently provide sufficient strength for strangulating the nose cone of the grenade.

5 Figs. 6-8 show three main applications of the device according to the invention.

In the application shown in Fig. 6, the netting 5 of the device is disposed at a distance in the order of 10 m from the object 0 to be protected, for example a building.

10 In this application the netting has a DON (Detonation on Net) function, to reduce the damage of the detonation (the force of the hollow charge rapidly decreases with distance), as a DUD, i.e. prevent detonation.

15 In the embodiment shown in Fig. 7, the netting 5 of the device is used in combination with protection means of the building, for example an ammunition depot or a military post. Additional protection means may consist of a protection wall P, for example a stone-filled grid wall. In this application the netting can be disposed a

20 significantly smaller distance from, in this case, the additional protection wall, for example a distance in the order of 1-2 m. The netting also has a DON or a DUD function in this case.

25 In the embodiment shown in Fig. 8, the netting 5 primarily has a DUD function, and the netting is disposed very close to the object 0 to be protected, in particular to the armour plating of the object. In this application the objects mainly consists of mobile objects, in particular vehicles and vessels and other mobile modules.

30 The netting may be disposed a very short distance from the object in that case, for example a distance in the order of 15-50 cm. The netting 5 may be disposed in front of the armour plating and as well as in front of the wheel housings to protect wheels, caterpillar tracks and the like.

35 Fig. 9 shows a first possible way of attaching the

netting of the device according to the invention to the (armour plating of the) object. First a spacer is mounted to the object 0, and subsequently the netting 5 is stretched over said spacer. The spacer may consist of a 5 foam layer or an air cushion or the like, for example, which does not need to exhibit any strength of its own but which only functions to keep the netting in place. The netting may be frameless netting, therefore. The netting may be stretched over the spacer by means of bars 9 or 10 other means of attachment, for example, but the net may also be integrated in the spacer, so that the spacer also functions as a means of attachment. The net may be hidden from view or be camouflaged by suitably selecting the spacer and the combination of the netting therewith, so 15 that it is unclear to attackers if and how the object is additionally protected. The nets may be provided over a large part of the surface area of the object or at critical places thereof. The netting must preferably be disposed in such a manner that it can catch grenades being fired from 20 different directions.

Fig. 10 shows a second embodiment, in which the object 0 consists of a hull of a ship. The netting may be suspended from the upper side of the ship's hull in this case, whilst spacers 8 again maintain the required spacing 25 between the netting and the ship's hull. A weight 10 at the bottom side of the netting keeps the net properly stretched.

From the foregoing it will be understood that the invention provides a protection device that is remarkable 30 for its effectiveness at a low weight. The device can be disposed a very short distance from the object to be protected, rendering it quite suitable for use with mobile objects.

The invention is not restricted to the embodiments as 35 described above and shown in the drawings, which can be varied in several ways without departing from the scope of

the invention.

Explanatory notes to Fig. 5 of the drawings regarding possible hit locations on the net:

5

- A Edge of mesh
- B Grazing leg
- C Centre of mesh
- D Centre of knot
- E Centre of leg

CLAIMS

1. A method for protecting objects against rocket-propelled grenades (RPGs) having a hollow nose cone, wherein a netting of preferably knotted and coated superstrong fibres is disposed in front of the object, 5 wherein the size of the meshes of the netting has been selected so that the nose cone of a rocket caught in the netting will penetrate one of the meshes of the netting and be deformed through strangulation, thereby disabling the detonator.

10 2. A device for protecting objects against rocket-propelled grenades (RPGs), comprising a netting of superstrong fibres, which are preferably knotted and provided with a flexible coating, formed with a plurality of meshes having a stretched mesh length of maximally about 15 8 cm.

3. A device according to claim 2, wherein the stretched mesh length ranges between 7 cm and 8 cm.

4. A device according to claim 2 or 3, wherein the netting is pre-stretched after being knotted, preferably with a force such that the fibres are loaded to a tension 20 of about 0.2 to 0.5 times the breaking stress.

25 5. A device according to any one of the claims 2-4, wherein the netting is so configured that the meshes are capable of withstanding a circumferential load of minimally about 3 kN, and wherein the mesh legs preferably have a diameter of maximally about 4 mm.

30 6. A device according to any one of the claims 2-4, wherein the meshes are formed by at least three mesh sides, each mesh side being made up of at least two separate fibres, which preferably extend at least substantially parallel to each other.

7. A device according to any one of the claims 2-6, wherein the meshes are provided with projections, such as

beads, between the knots thereof.

8. A device according to any one of the claims 2-6, provided with two nettings disposed one behind the other, perpendicular to the plane thereof.

5 9. A device according to any one of the claims 2-6, wherein each knot is a double knot.

10 10. A device according to any one of the claims 2-9 for use on an armoured vehicle provided with means of attachment for disposing the netting at a distance of about 15-50 cm from the armour plating.

15 11. An armoured vehicle or vessel provided with armour plating and with a device according to any one of the preceding claims, provided with means of attachment for disposing the netting of the device at a distance of, preferably, about 5-15 cm from the armour plating.

12. A vehicle according to claim 11, wherein a foam material or an air cushion is placed between the vehicle and the netting, and wherein the netting is preferably stretched against the foam material or the air cushion.

20 13. A vehicle according to claim 11, wherein the air cushion is inflatable and comprises one or more sensors for detecting an acute threat and causing the air cushion to inflate.

25 14. A vehicle according to claim 11, 12 or 13, wherein the netting is attached on opposite sides thereof to a suspension means, for example a bar or a tube.

30 15. A device for protecting a fortified military post, such as an observation tower or observation post, wherein the netting is suspended from a frame at its circumference, or at least at the upper side and the bottom side, at a distance of at least 50 cm, and preferably about 1.50 m, from the object.

35 16. A method for manufacturing netting for use as a means of protection against RPGs, comprising the steps of: forming the knotted netting from superstrong fibres; impregnating the obtained netting with a flexible

coating;
allowing the coating to dry; and
pre-stretching the knotted netting at least once and
preferably a number of times.

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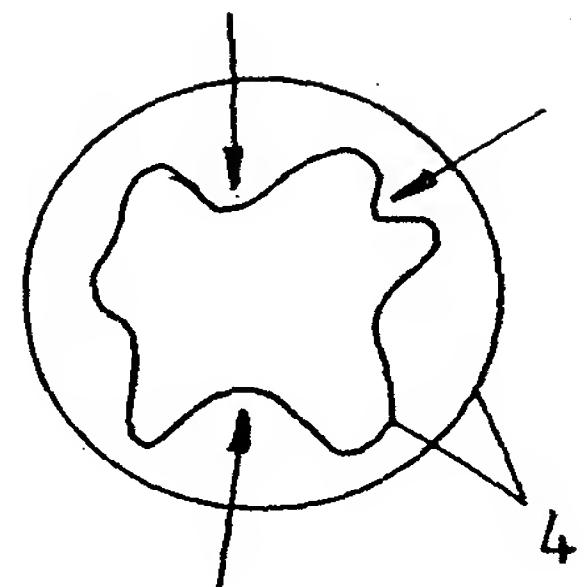


Fig. 2

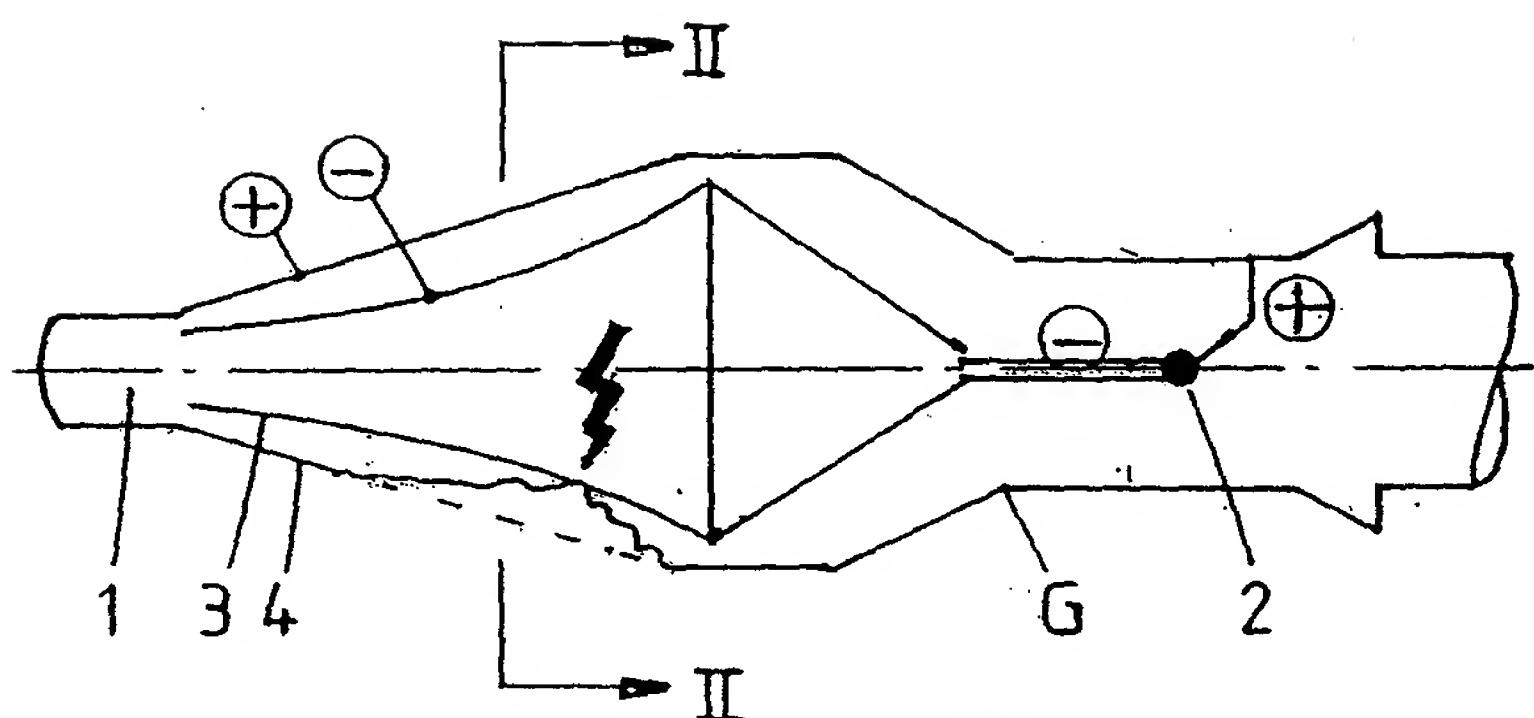


Fig. 1

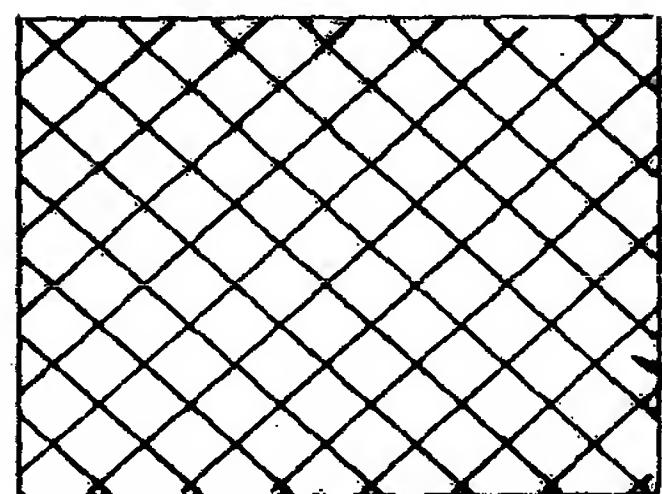


Fig. 3

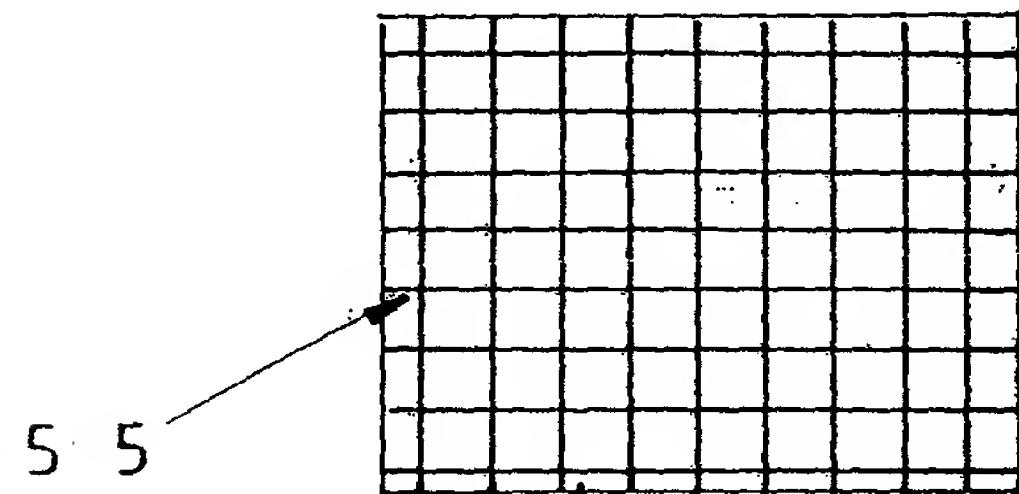


Fig. 4

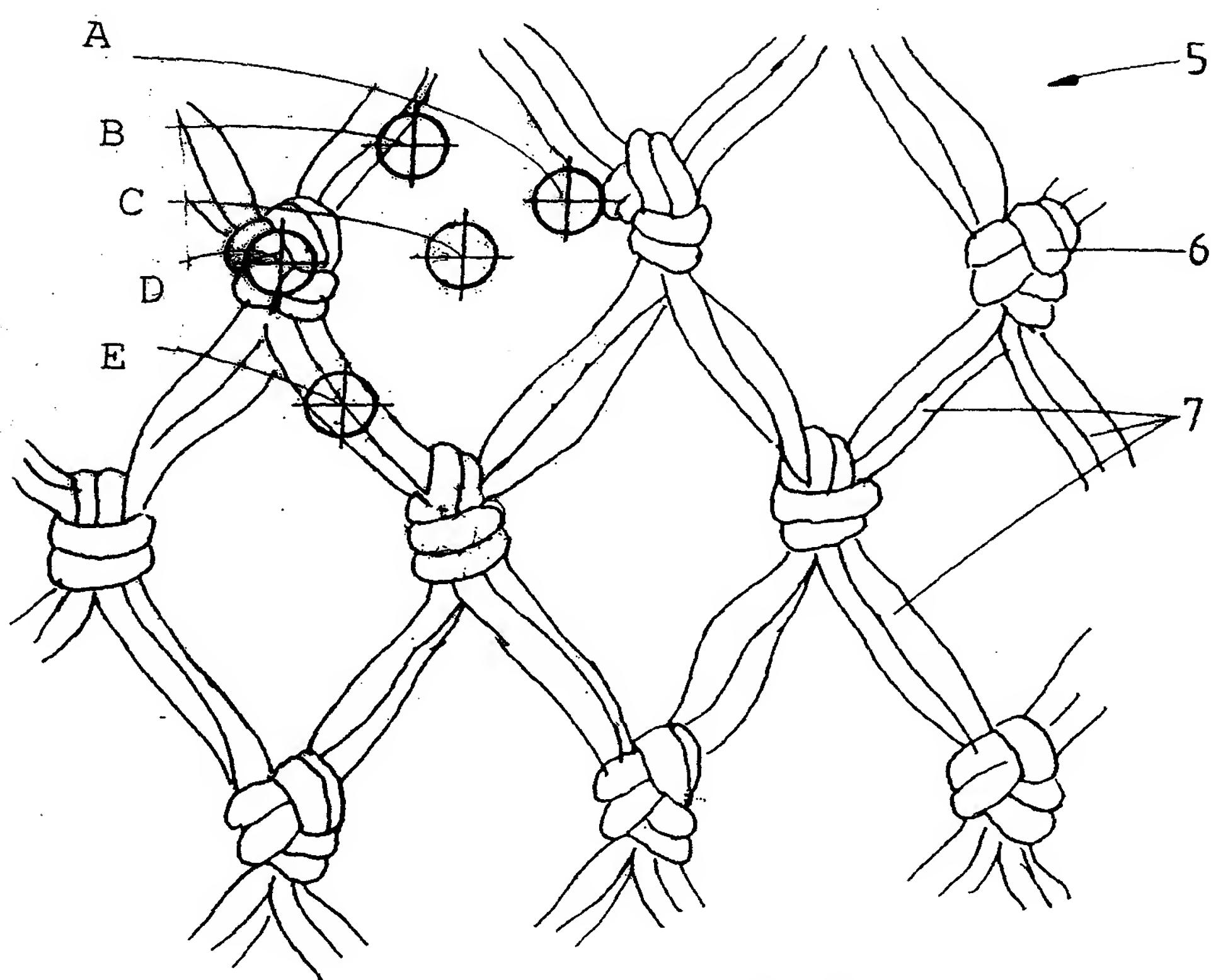


Fig. 5

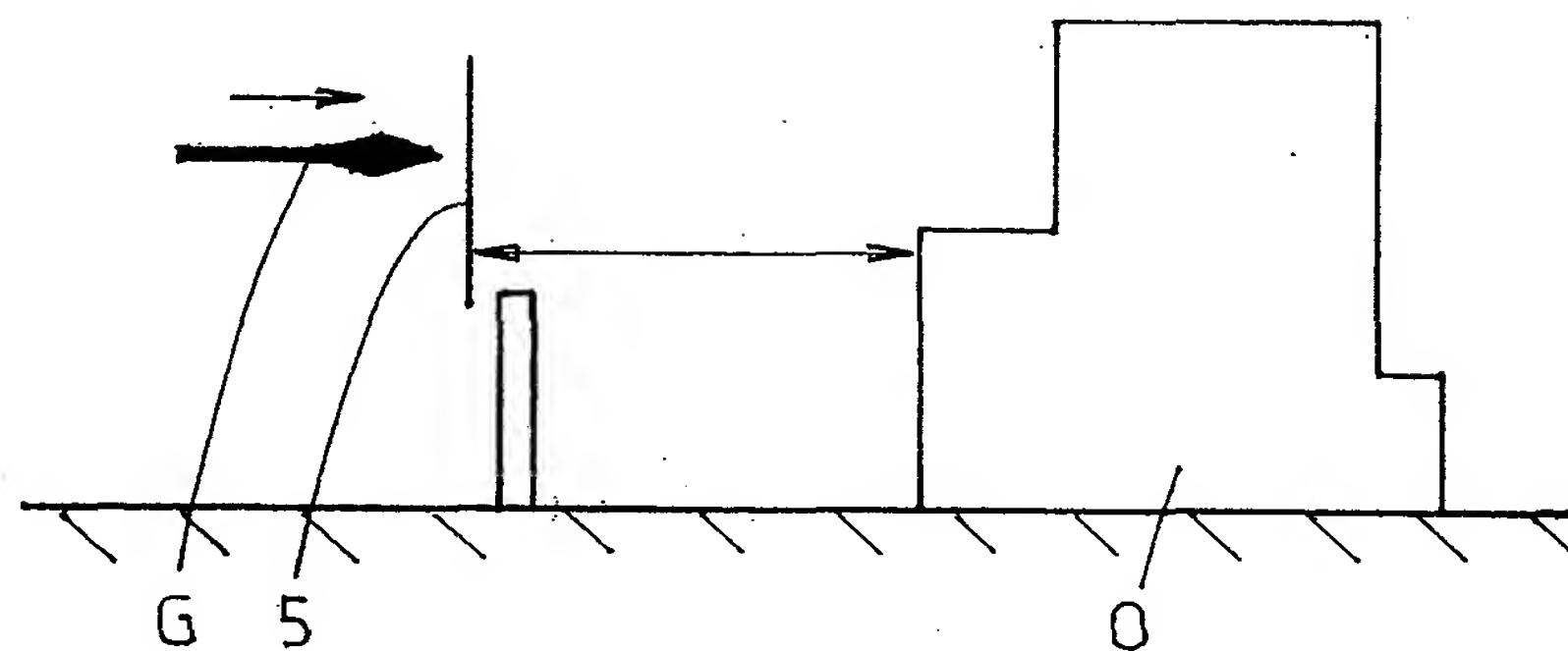


Fig.6

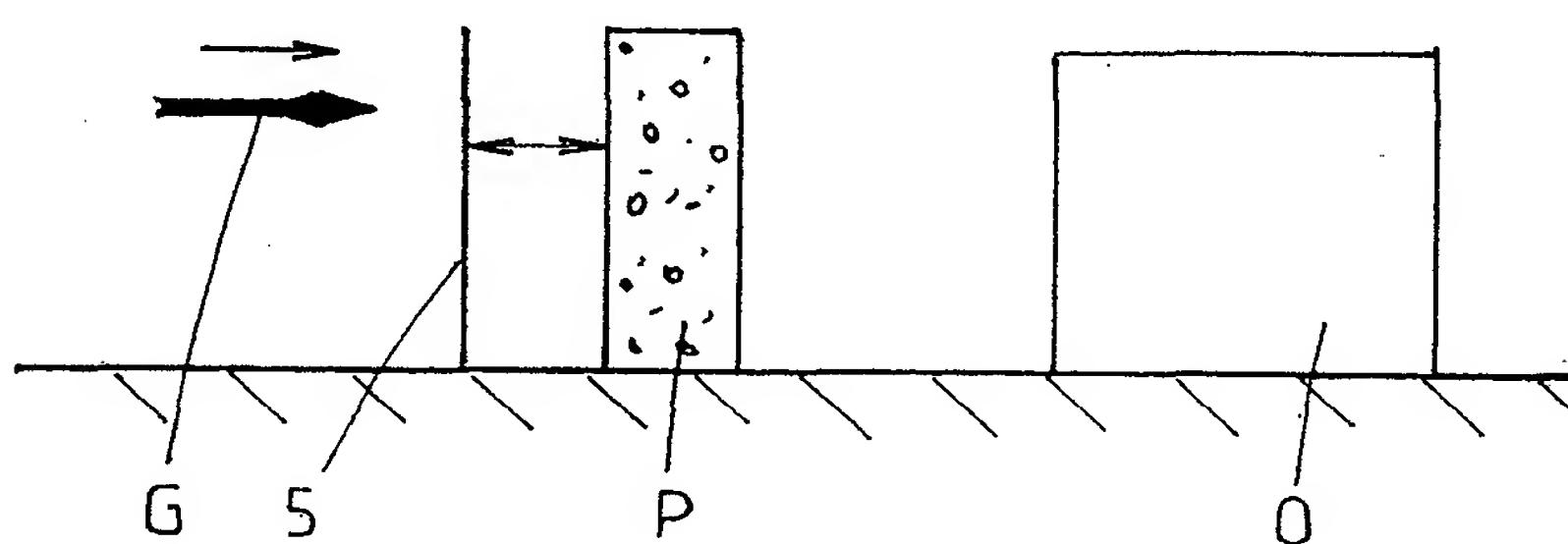


Fig.7

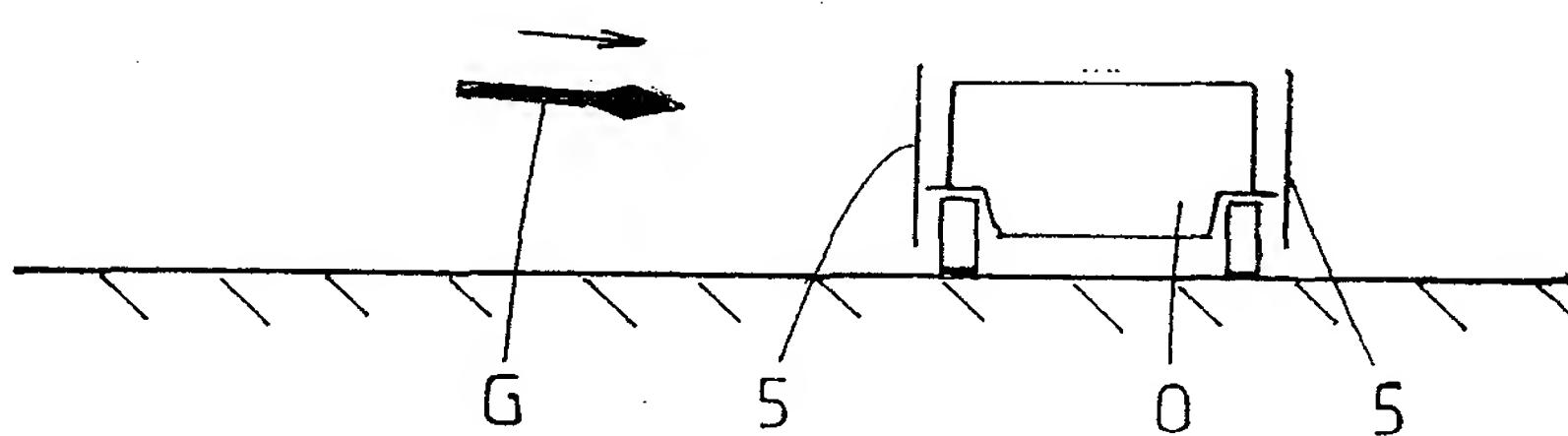


Fig.8

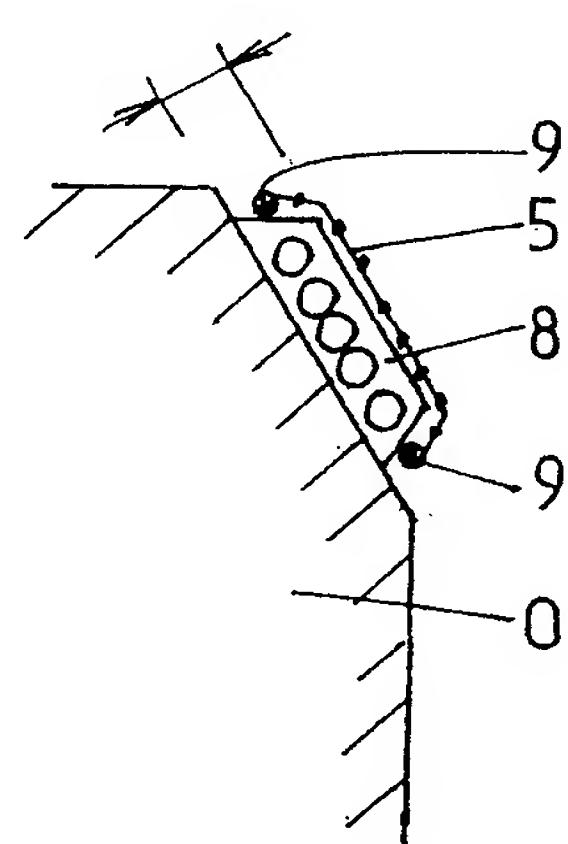


Fig.9

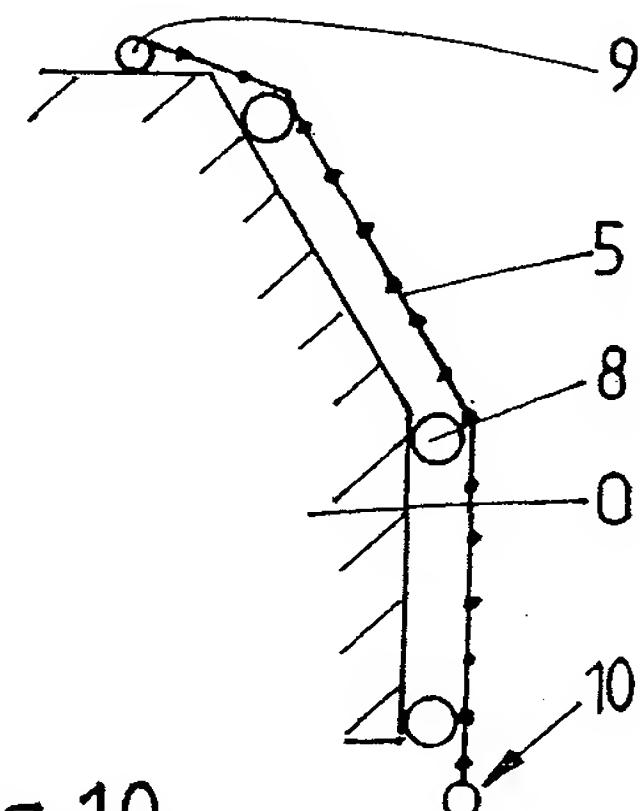


Fig.10

INTERNATIONAL SEARCH REPORT

International application No

PCT/NL2007/050679

A. CLASSIFICATION OF SUBJECT MATTER
INV. F41H11/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F41H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/135432 A (MITITECH LLC [US]; SCHWARTZ CRAIG A [US]) 21 December 2006 (2006-12-21) abstract paragraph [0007] paragraph [0031] figures	1,2,15
Y A	----- HUNTILLER M: "ASYMMETRICAL WARFARE - ARMOUS" ARMADA INTERNATIONAL, ARMADA INTERNATIONAL, ZURICH, CH, vol. 28, no. 6, December 2004 (2004-12), pages 38-40,42, XP001230677 ISSN: 0252-9793 page 2 - page 3 -----	11,12 16
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See patent family annex.

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INTERNATIONAL SEARCH REPORT

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